THE MASS-EXCHANGE BINARY SCO X-1

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Abstract. Data on the binary character of Sco X-1 are presented.

The spectroscopic data of Cowley and Crampton (1975) are presented. These are radial velocities of He II λ 4686 Å from ~60 spectra taken on four out of five nights during a quiet epoch of the optical star. Orbital motion with a period of ~0.787 days is clearly indicated, and yields a mass-function of 0.016. The line and continuum emission is assumed to originate in an accretion ring around the X-ray source, as no other model can fit all the observed quantities. The invisible mass-losing star is considered to be evolved about 1 mag above the main sequence as no star of mass $\lesssim 4.0 M_\odot$ has a main sequence radius large enough to fill its Roche lobe. The light curve of ~0.2 mag amplitude discovered by Gottlieb *et al.* (1975) has its maximum when the mass-loss star is in conjunction behind the X-ray source, implying the presence of a heating effect, considerably less than that seen in HZ Her. Assuming that X-radiation is blanketed or scattered in the orbital plane by matter accreting at a supercritical rate, we obtain possible system parameters shown in Table I, with the assumptions given. Likely parameters seem to be $M_1 \simeq M_2 \simeq 1.3 M_\odot$; $i \simeq 30^0$, distance ~1700 pc.

TABLE I

Sco X-1 system parameters

$f(m) = 0.016$

Optical stars 1 mag above ZAMS, $>1^m.5$ fainter than Sco X-1 system
X-ray luminosity at Eddington limit

Distance (pc)	$\frac{M_X}{M_\odot}$	$\frac{M_{OPT}}{M_\odot}$	X-ray (erg s^{-1})	q (M_2/M_1)	$\frac{R_{roche}}{sep.}$	i	$\frac{dM_{OPT}}{dt}$ ($M_\odot$ yr^{-1})
1200	0.7	1.4	7×10^{37}	2	0.41	17°	2×10^{-7}
1200	0.7	1.0	7×10^{37}	1.4	0.37	23°	3×10^{-8}
1200	0.7	0.5	7×10^{37}	0.7	0.33	40°	$<10^{-8}$
2400	2.0	1.2	2×10^{38}	0.6	0.31	28°	2×10^{-7}
2400	2.0	1.0	2×10^{38}	0.5	0.30	32°	3×10^{-8}
2400	2.0	0.8	2×10^{38}	0.4	0.28	40°	$<10^{-8}$

References

Cowley, A. P. and Crampton, D.: 1975, *Astrophys. J.* **201**, L65.
Gottlieb, E. W., Wright, E. L., and Liller, W.: 1975, *Astrophys. J.* **195**, L33.

P. Eggleton et al. (eds.), Structure and Evolution of Close Binary Systems, 319–320.

DISCUSSION

Tsuruta: If the Roche lobe of the primary of Sco X-1 is underfilled, how do you explain the mass flow needed to explain the high luminosity observed?

Hutchings: The Roche lobe is underfilled if the primary star is a main sequence star. This means that the primary star has evolved off the main-sequence branch, possibly to a subgiant stage.

Wilson: Since the estimated distance (or at least the upper limit) for Sco X-1 is based on the strengths of interstellar lines, and since you run out of the disk of the galaxy after about a kiloparsec in the direction of Sco X-1, does it seem likely that Sco X-1 is a considerable factor further than previously estimated?

Hutchings: As far as I know the interstellar lines give only a lower limit as Sco X-1 is at a high galactic latitude. This lower limit is about 300 pc.

https://doi.org/10.1017/S0074180900012110 Published online by Cambridge University Press